

## 4.6 EARTH RESOURCES

This section evaluates the potential geological impacts that could occur with implementation of the project. A Preliminary Geotechnical Investigation of the project site was performed by Geo/Resource Consultants in 1990. This report was peer-reviewed by Hallenbeck/Allwest Geoscience in 2004 to confirm that site conditions have not substantially changed since its preparation. The peer-review included a confirmation field reconnaissance survey of the project site on January 21, 2004. The following provides a summary of the results of the Preliminary Geotechnical Investigation. A copy of this report is available for review at the California Department of Corrections, 501 J Street, Room 304, Sacramento, California.

As described in Chapter 4.0, where appropriate and relevant, the analysis in this section identifies the differences in impacts that would be anticipated to occur with implementation of the project under 4 conditions: budgeted inmate capacity, maximum design inmate capacity, single level design option, and stacked design option. In the case of earth resources, the single level and stacked design option could result in varying degrees of the soil stability/instability on the site depending on the structural loads that are placed on these soils. Therefore, for relevant impacts this section describes the differences between the design options. The number of inmates housed at SQSP would have no bearing on this issue and is not considered in this analysis.

### 4.6.1 EXISTING CONDITIONS

#### GEOMORPHIC SETTING

SQSP is located on the southern shoreline of Point San Quentin, along the northwestern margin of San Francisco Bay. The San Francisco Bay region is bordered by mountain ranges of the Coast Range Geomorphic Province. The project site and vicinity are underlain primarily by Franciscan mélange bedrock at depth, artificial fill, colluvium, and bay mud/marsh deposits. The Franciscan mélange bedrock consists predominately of interbedded sandstone (greywacke) and shale in either a shale or clay matrix and has been observed in outcroppings on hillside areas on and adjacent to SQSP and on the exposed cut slopes of Dairy Hill (Geo/Resource Consultants, Inc.1990). Dairy Hill is the most prominent landmark on the site and consists of a small bedrock mound.

The project site is located on the westernmost portion of SQSP grounds and is relatively level (except Dairy Hill) to gently sloping. The site is located on a broad plain (old marshland basin) that slopes gently from the hills to the north to the San Francisco Bay margin to the south. Topographic maps dating back to 1926 indicate that approximately half of the project site was originally part of San Francisco Bay and consisted of tidal marsh/flats.

The following earth materials are located on the project site (Geo/Resource Consultants, Inc.1990):

- fill soils consisting variably mixed silt, clay, sand, and gravel. The fill does not appear to be of uniform thickness or degree of compaction, but appears to be heterogeneous across the site;
- bay mud consisting of soft, organic, silty clay that is highly compressible with low shear strength. The bay mud is restricted to the southeast portion of the site;
- silt/clay consisting of sand, gravel, and some weathered rock fragments; and
- Franciscan mélange bedrock, which is a tectonically mixed assemblage of sandstone, shale conglomerate, chert, greenstone, blue schist, amphibolite, and serpentine.

Soils present on the project site are generally separated into 3 areas: northeast; southeast; and western (Dairy Hill). The northeast portion of the project site generally consists of a thin layer of fill material (i.e., 1 to 5 feet) which is underlain by brown silt/clay and bedrock material. The southeast portion of the site generally consists of fill material (at depths of 2 to 8 feet), including brick fragments, that is underlain by bay mud and brown sandy-silty clays. The bay mud is generally thinner in the center of the project site and increases in thickness toward San Francisco Bay (to the south). The western portion of the project site consists of an outcropping of Franciscan mélangé bedrock.

The entire project site has historically been altered by past grading and construction activities including the placement of fill materials in the northern portion of the site and the deposition of brick materials in the southern portion of the site.

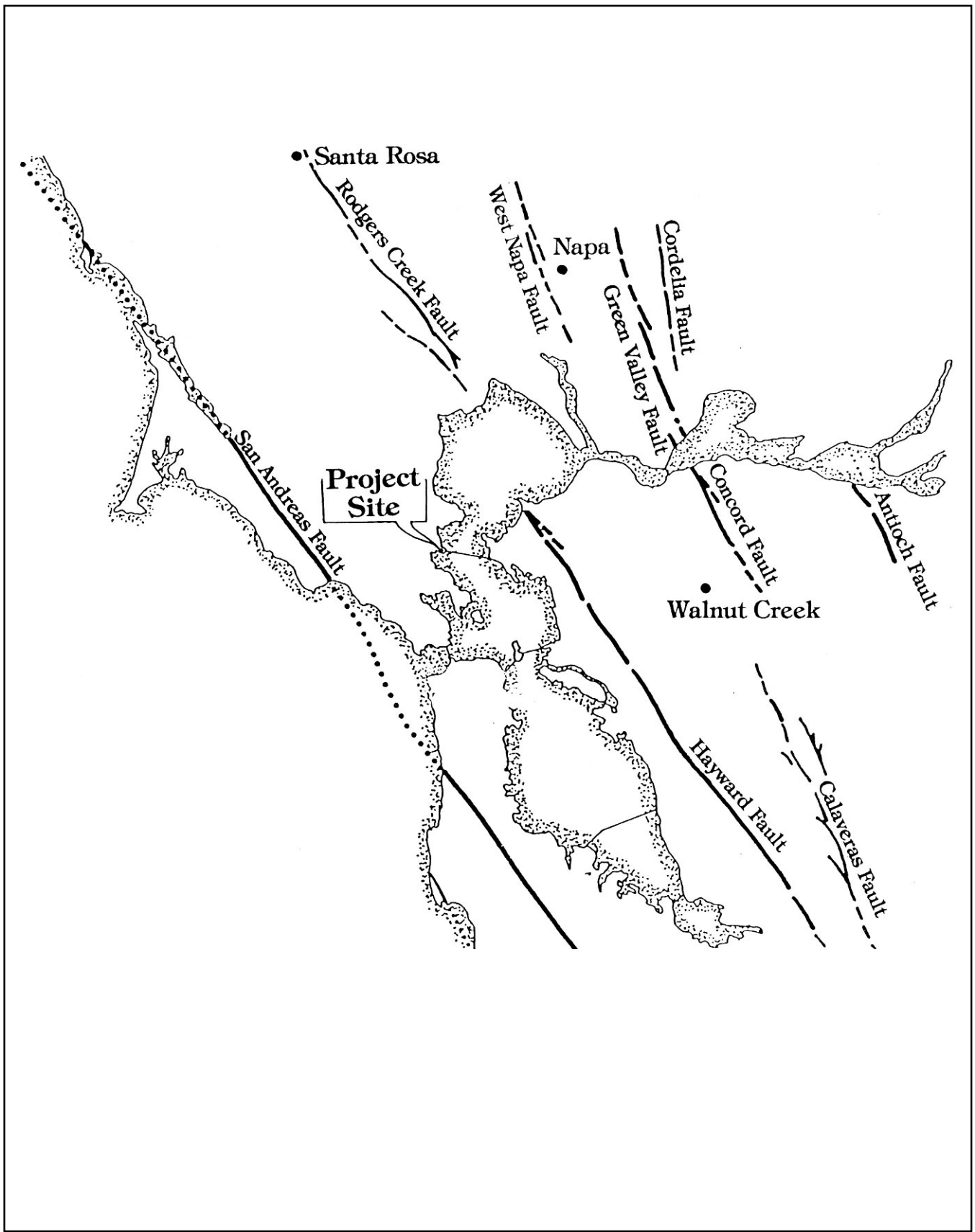
## SEISMICITY

The Coast Range Geomorphic Province is a geologically young and seismically active region. The uplift of the Coast Ranges and associated seismic activity is the result of movement along the San Andreas Fault System that consists of three major active fault zones. These zones include the active San Andreas, Hayward, and Calaveras faults and associated fault traces. The San Andreas Fault is located approximately 9 miles southwest, the Hayward Fault is located approximately 9 miles northeast, and the Calaveras Fault is located approximately 17.5 miles northeast of the project site. Active fault traces associated with these fault zones include the Rogers Creek Fault, Green Valley Fault, and Concord Faults, which are located 14.5 miles northeast, 24 miles northeast and 22 miles northeast of the site, respectively. A trace of the potentially active San Pablo Fault was mapped approximately 5 miles northeast of the site. Exhibit 4.6-1 presents the location of the nearest fault zones and associated fault traces.

The strongest earthquake in the Bay Area during historic time was the 1906 earthquake on the San Andreas Fault. This earthquake had a Richter-scale magnitude of approximately 8.3. The most recent strong earthquake that affected the Bay Area was the Loma-Prieta Earthquake in 1989, which had a magnitude 7.1. The epicenter of this earthquake was located approximately 68 miles southeast of the project site. Structures on the project site and in the immediate vicinity suffered no apparent damage.

The Hayward fault has generated two historic earthquakes of approximately magnitude 7, in 1836 and 1868. An earthquake occurred along the Calaveras fault in 1861 with an estimated magnitude of 5.6. Table 4.6-1 lists the estimated maximum credible earthquake magnitudes and anticipated bedrock acceleration at the project site.

<b>Table 4.6-1 Estimated Earthquake Magnitude Parameters</b>		
<b>Fault</b>	<b>Maximum Credible Earthquake Magnitude (Richter)</b>	<b>Maximum Estimated Bedrock Acceleration (g)</b>
San Andreas	8.25	0.48
Hayward	7.50	0.47
Calaveras	7.50	0.18
Rodgers Creek	7.0	0.34
Source: Borchardt, et al. 1975, Greensfelder 1973		



Source: Borcherdy 1975; Jennings 1975; Helly and Herd 1977; Herd and Helly 1977

## Regional Fault Map

EXHIBIT 4.6-1

No active or potentially active faults have been mapped on or are in close proximity to the project site. The site is not located in an Alquist-Priolo Earthquake Fault Zone or in a State of California Seismic Hazard Zone.

## **LIQUEFACTION**

Liquefaction occurs when water-saturated soils composed of silt or gravel are subjected to shaking by an earthquake. If the water is unable to drain, the soil assumes the property of a heavy liquid and no longer provides adequate support for foundations, buildings, or upper layers of soil. Liquefaction can cause severe damage to structures as a result of settling, tilting, or floating.

According to the California Division of Mines and Geology Seismic Hazard Zone Map for the San Quentin Quadrangle, the project site is not located in a California Seismic Hazard Zone for liquefaction. In addition, the geotechnical report prepared by Geo/Resource Consultants, Inc., (1990) concluded that liquefaction potential at the site would be relatively low because of the presence of fine-grained clay sediments beneath bay mud deposits. Although shallow groundwater exists within 5 to 7 feet of the ground surface, the bay mud/bay marsh deposits underlying the site are considered to have a low liquefaction potential.

## **LATERAL SPREAD**

Lateral spread refers to landslides that form on gentle slopes as a result of seismic activity and have a fluid-like movement. Soils at the project site consist of bay mud that is compressible, unconsolidated, and has relatively low dry densities. Fill overlies bay mud in the southeastern portion of the site (Geo/Resources Consultants 1990). Although bay mud is not generally prone to seismically induced lateral spread, there may be potential for lateral spread in the overlying sand and silt fills and any sand layers that may be present in the bay mud. It is anticipated that the most severe lateral spread potential would occur within 100 feet of existing shoreline areas where sand/silt fill material overlies the bay mud and shallow groundwater is present (Hallenbeck/Allwest Associates 2004).

## **EXPANSIVE SOILS**

Highly plastic clay soils found near the ground surface at the project site undergo seasonal moisture changes that could subject these soils to shrink/swell behavior. Sand/silt soils with low plasticity (Plasticity Index of 6 to 10) were found throughout the upper soil layers on the project site (Geo/Resource Consultants 1990). Based on these findings, there would be a low probability of shrink/ swell soil behavior at the project site (Hallenbeck/Allwest Associates 2004).

## **LANDSLIDES**

The project site is not located in a State of California Seismic Hazard Zone for landslides. A steep excavated cut slope exposing hard bedrock is located along the southern base of Dairy Hill. The nearly vertical cut slope has the potential for minor rockfall, but there is little potential for large-scale landsliding because of the dense nature of the bedrock. In general, the remaining slopes along Dairy Hill are gradually inclined and would have low potential for landsliding (Hallenbeck/Allwest Associates 2004).

Moderately steep sloping terrain exists north of the project site (across Sir Francis Drake Boulevard). Evidence of several shallow debris flows and rotational earth slump landslides is present on these steep slopes. The areal extent of the shallow landslides varies from 20 to 50 feet in width and 50 to 100 feet in length. The project site is located greater than 300 feet south of these landslide areas.

## **TSUNAMIS**

A tsunami can be caused by an offshore earthquake, volcanic activity, or landslide. Tsunamis can inundate low-lying areas and cause extensive erosion and the deposition of sediment. Facilities that are poorly constructed can be severely damaged by the incoming and outgoing waves. The project site lies in an area that could be inundated by tsunami waves if the waves are substantially large (i.e., greater than 20 feet). A tsunami wave of the size that would produce a 20-foot runup at the Golden Gate Bridge could result in a wave run up at SQSP of approximately 10 feet. The energy of a tsunami wave that enters the mouth of the Golden Gate would be attenuated while moving into the open water of the bay and would decrease by 50% by the time it passes the Richmond-San Rafael Bridge (Ritter and Dupre 1972). The recurrence interval for a tsunami of this size is estimated to be 200 years.

Based on ground elevations along the shoreline of SQSP and assuming a tsunami runup of 10 feet at SQSP, it is estimated that approximately 150 feet of the shoreline in the project area could be subjected to various levels of inundation caused by a tsunami. If a tsunami wave has a runup of 10 feet approaching SQSP, all areas abutting the bay that have ground elevations less than 10 feet above mean sea level may be subjected to some level of inundation (Hallenbeck/Allwest Associates 2004).

### **4.6.2 REGULATORY BACKGROUND**

#### **STATE OF CALIFORNIA BUILDING CODE**

All development in the State of California must comply with the provisions of the California Building Code (CBC) at a minimum. The CBC provides minimum requirements for grading, building siting, development, and seismic design. Structures constructed at SQSP would comply with the CBC.

#### **ALQUIST-PRIOLO EARTHQUAKE FAULT ZONING ACT**

The purpose of the Alquist-Priolo Earthquake Fault Zoning Act is to prevent the construction of buildings used for human occupancy on the surface trace of active faults. The Act only addresses the hazard of surface fault rupture and is not directed toward other earthquake hazards. As described above, the project site is not located in an Alquist-Priolo Earthquake Fault Zone.

#### **SEISMIC HAZARDS MAPPING ACT**

The Seismic Hazards Mapping Act, passed in 1990, addresses non-surface fault rupture earthquake hazards, including liquefaction and seismically induced landslides. The law requires the State Geologist to establish regulatory zones (known as Earthquake Fault Zones) around the surface traces of active faults and to issue appropriate maps. As described above, the site is not located in a State of California Seismic Hazard Zone.

### **4.6.3 ENVIRONMENTAL IMPACTS OF THE PROJECT**

#### **THRESHOLDS OF SIGNIFICANCE**

The project would result in significant earth resources impacts if it would:

- expose people or structures to substantial adverse effects including the risk of loss, injury or death involving:

- ▶ rupture of a known earthquake fault;
  - ▶ strong seismic ground shaking;
  - ▶ seismic-related ground failure, including liquefaction; or
  - ▶ landslides.
- result in substantial soil erosion or loss of topsoil;
  - be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or offsite landsliding, lateral spreading, subsidence, liquefaction or collapse; or
  - be inundated by a tsunami.

## SEISMIC HAZARD IMPACTS

Fault rupture can occur along fault systems during seismic events (earthquakes). If the rupture extends to the surface, movement on a fault is visible as a surface rupture. The occurrence of a fault rupture depends on several factors including location of the epicenter in relation to the project site and the characteristics of the earthquake, such as intensity and duration. The hazards associated with fault rupture generally occur in the immediate vicinity of the fault system. The project site is not located in a designated Alquist-Priolo Earthquake Fault Zone. Because active faults were not identified on the project site, ground rupture would not be anticipated.

Strong earthquakes generated along a fault system generally create ground shaking, which attenuates (i.e., lessens) with distance from the epicenter. In general, the area affected by the ground shaking would depend on the characteristics of the earthquake and location of the epicenter. As described above, no active faults were identified on the project site, nor is the project site located in a designated Alquist-Priolo Earthquake Fault Zone. However, the site is located in an area subject to strong ground shaking from earthquakes generated along the active San Andreas, Hayward, and Calaveras fault systems. These fault systems could generate strong ground shaking intensities of magnitude 7 or 8, which could result in structural damage to buildings. The project (under either design options) would be designed in accordance with the most recent CBC design standards including seismic standards for buildings.

*The project site is not located in a designated Alquist-Priolo Fault Zone, nor are any active faults identified on the project site. Therefore, ground rupture would not be anticipated at the project site. The site is located in an area subject to strong ground shaking (magnitude 7 to 8), which could result in severe structural damage. Because the project would be designed in accordance with the most recent provisions of the California CBC including seismic design criteria for buildings, the project's seismic hazard impacts would be less than significant (Impact 4.6-a).*

## LIQUEFACTION AND SEISMIC-RELATED GROUND FAILURE IMPACTS

Primary factors in determining liquefaction potential are soil type, level of duration of seismic ground motions, and depth to groundwater. Sandy, loose, unconsolidated soils are most susceptible to liquefaction hazards. Seismically induced ground failure is typically caused by densification of subsurface soils during and immediately following earthquakes. The project site is not located in a California Seismic Hazard Zone for liquefaction. However, localized sand lenses could be present in the southeast portion of the project site and could be subject to seismically induced liquefaction.

Although bay mud is not generally prone to seismically induced lateral spread, there may be potential for lateral spread in the overlying sand and silt fills and any sand layers that may be present in the bay mud.

It is anticipated that the most severe lateral spread potential would occur within 100 feet of the existing shoreline where sand/silt fill material overlies the bay mud and shallow groundwater is present (Hallenbeck/Allwest Associates 2004). No buildings would be located within this 100-foot shoreline area. However, the outer perimeter road and portions of the electrified fence would be located in this area.

Areas underlain by colluvial soil or shallow bedrock (i.e., northern and western portion of the site) are not susceptible to seismically induced ground failure, as these materials are relatively strong and undeformable. However, those areas of the site which are underlain by fill and bay mud (i.e., southern portion of the site) could be subject to settlement during a strong earthquake, which could cause cracking of pavement and foundations and would have a significant potential for ground failure or displacement induced by strong seismic shaking. In general, the greater the structural load on bay mud, the greater the potential for structural damage. Therefore, because the stacked design option would place greater structural loads (i.e., 2-story 180 Degree Housing Units) on bay muds in the southern portion of the site, this design option would have greater potential for ground failure and displacement compared to the single-story design option (i.e., 1-story 180 Degree Housing Units).

*Although the project site is not located in a seismic hazard zone for liquefaction, localized areas in the southeast portion of the project could be subject to seismically induced liquefaction. Lateral spread could occur along shoreline areas of the project site where sand/silt fill material overlies bay mud and shallow groundwater is present. Further, construction of project facilities on bay mud could result in seismically induced ground failure and ground deformation. These impacts would be potentially significant (Impact 4.6-b).*

## **SOIL EROSION IMPACTS**

Erosion is a natural process where soil is removed by water, wind, or gravity from one location to another. Grading activities remove the natural vegetative cover that protects the soil from erosion. Because of the gently sloping topography of the majority of the project site, the potential for erosion at the site would be low. However, construction activities that remove or disturb vegetation, redistribute onsite soils, and stockpile onsite soils (i.e., excavation and trenching), could result in wind and water erosion at the site. Because the project site is larger than 1 acre, CDC would be required to obtain a National Pollutant Discharge Elimination System (NPDES) permit from the State Water Resources Control Board (SWRCB). The NPDES permit would require CDC to develop and implement a Stormwater Pollution Prevention Plan (SWPPP), which specifies Best Management Practices (BMPs) that would prevent erosion impacts to the project site and San Francisco Bay. BMPs for the project would include the use of silt fences and straw bales to prevent runoff from the active grading areas, use of proper grading techniques, shoring and bracing of the construction areas, and covering or stabilizing stockpiles of soil and other earth materials. In addition, the project site is located within the San Rafael urbanized area as designated by the 2000 U.S. Census. As part of the requirements of Phase II of the NPDES Stormwater Program, signed into law in December 1999, smaller communities in urbanized areas known as municipal separate storm sewer systems (MS4s) are required to apply for permit coverage under the NPDES program. The permit requires the MS4 to develop and implement a comprehensive stormwater program that includes public education and outreach, public involvement, illicit discharge detection and elimination, construction runoff control, post-construction runoff control, and pollution prevention and good housekeeping for ongoing operations. The project site is located within Marin County. The Marin County Stormwater Pollution Prevention Program (MCSTOPP) submitted a SWPPP to the SWRCB in March 2004 to comply with the General Permit for the discharge of stormwater for small MS4's.

*Because CDC would be required to obtain a NPDES permit from the SWRCB, which identifies measures to prevent erosion impacts to the project site and San Francisco Bay, the project's erosion impacts would be less than significant (Impact 4.6-c).*

#### **COMPRESSIBLE AND CORROSIVE SOILS**

Fill soils underlying portions of the site could be unsuitable for foundation support. Some of the fill soils may be poorly compacted or may contain debris that could be subject to uneven settlement or may cause construction difficulties if encountered in foundation excavations. Brick debris was encountered in fill material at depths of 1 to 5.5 feet in the southeastern portion of the site (Geo/Resource Consultants, Inc.1990). The areal extent of this material in the project site would be determined during design-level geotechnical investigations.

Test borings on the site indicate that as much as 30 feet of weak, compressible bay mud underlies the southeast portion of the site. These soils have low bearing capacities that may be insufficient to support shallow foundations and may be subject to significant settlement under loads imposed by proposed fills or structures. Excessive settlement beneath foundations could cause structural damage to buildings, particularly if the amount of settlement is not uniform beneath the building (Geo/Resource Consultants, Inc. # 1990).

Resistivity measurements and chloride concentrations found in bay mud deposits could create a corrosive environment for steel pipes and steel reinforcement in concrete. During the life of the project, reinforced concrete foundations, driven precast pilings and culverts could be adversely degraded by the corrosive nature of the bay muds (Geo/Resource Consultants, Inc.1990).

*The presence of weak, compressible soils that may be unsuitable for foundation support and/or that may contain debris could result in structural damage to proposed facilities. Further, corrosive soils on the site could degrade foundations and other project facilities. This would be a potentially significant impact (Impact 4.6-d).*

#### **LANDSLIDE IMPACTS**

The project site is not located in a State of California Seismic Hazard Zone for landslides. Further, the proposed removal of Dairy Hill would eliminate any potential for landslide hazards on the project site.

*Because the project site is not located in a seismic hazard zone for landslides and removal of Dairy Hill would minimize or eliminate the potential for landslides or slope instability on the project site, landslide potential would be a less-than-significant impact (Impact 4.6-e).*

#### **TSUNAMI IMPACTS**

Areas within 150-feet of the existing shoreline could be inundated by a tsunami wave with a run up of 10 feet (Hallenbeck/Allwest Associates 2004). However, the recurrence interval of tsunamis large enough to result in wave run up at the site would be greater than 200 years. No buildings are located in this wave run up zone. The outer perimeter road and the southern portion of the electrified fence could be subjected to wave inundation and sediment deposition. The electrified fence would be designed so that sections of the fence could be taken offline without affecting the integrity of the remaining fence line areas. If a tsunami wave were to reach the shore line of SQSP the southern portion the fence would need to be taken offline until the water recedes and deposited sediments are removed. The perimeter roadway would not be adversely affected by the wave run up.

*No buildings would be located within a wave run up zone of a 10-foot tsunami wave, the maximum expected at the site. Further, facilities (i.e., outer perimeter road and electrified fence) located in the anticipated wave run up zone would not be adversely affect during wave inundation. Because of the long recurrence interval of tsunami waves large enough to produce a wave run up at the project site (i.e., greater than 200 years), the potential for tsunami inundation would be less-than-significant (Impact 4.6-f).*

#### **4.6.4 PROPOSED MITIGATION MEASURES**

##### **LESS-THAN-SIGNIFICANT IMPACTS**

The following impacts were identified as less than significant, and therefore no mitigation is needed:

- 4.6-a:** Seismic Hazards
- 4.6-c:** Erosion Hazards
- 4.6-e:** Landslide Impacts
- 4.6-f:** Tsunami Impacts

##### **SIGNIFICANT IMPACTS THAT CAN BE MITIGATED TO A LESS-THAN-SIGNIFICANT LEVEL**

The following impacts were identified as significant. Mitigation is available to reduce each impact to a less-than-significant level and is recommended below:

##### **4.6-b: Seismic-Related Ground Failure Impacts**

- CDC will prepare design-specific geotechnical studies before preparation of final grading plans for the project site. These studies will delineate the areas potentially subject to liquefaction and seismic-related ground failure and would include subsurface exploration, soil sampling and laboratory testing of onsite earth materials. Buildings, facilities, or infrastructure proposed in these areas will conform to the design recommendations of the geotechnical engineer. Recommended geotechnical measures will address site grading, cut and fill, subdrainage, fill material quality, foundation type and design criteria, and other geotechnical measures. Measures to reduce liquefaction and ground failure impacts could include the construction of deep foundations, installation of driven piles, and extra reinforcement of foundation slabs.

##### **4.6-d: Compressible and Corrosive Soils**

- CDC will prepare design-specific geotechnical studies before preparation of final grading plans for the project site. These studies will delineate areas on the project site that have compressible or corrosive soils. Facility designs will conform to the recommendations of the geotechnical engineer. The following grading and foundation measures could be implemented to reduce the project's compressible and corrosive soils impacts:
  - ▶ Removal, conditioning, or treatment of compressible or unsuitable soils,
  - ▶ Importation or redistribution (i.e., Dairy Hill) of clean fill materials suitable for reuse as engineered fill,
  - ▶ Grading to provide suitably compacted soils to support planned building foundations, roadways and other structures,

- ▶ Construction of shallow, spread-type footings where bedrock is either exposed or confirmed to be at shallow depths (after grading),
- ▶ Structural reinforcement of building foundations,
- ▶ Construction of deep building foundations (i.e., cast-in-drilled-hole (CIDH) concrete piles or driven piles) in the southeastern portion of the site where thick layers of highly compressible bay mud is present,
- ▶ Construction of a structural mat foundation system would be possible as an alternative, if the lighter structures were designed as floating or partially compensated structures to minimize the bearing pressures on the subsurface soils, and/or
- ▶ Application of protective coatings to concrete and steel bars to reduce the potential for corrosion.
- ▶ Selection of materials (i.e., PVC pipe and concrete mix designs) that are resistant to the corrosive soils and installation of cathodic protection systems to reduce or eliminate the potential for corrosion.